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In Praise of Curiosity

LILY ROSS TAYLOR

The following address was delivered before the members, initiates, and friends of the Boston University chapter of Phi Beta Kappa, meeting in May 1959. Because her address has special relevance to research, and because Dr. Taylor speaks from wide and deep experience as a teacher, scholar, and administrator, it is appropriate that her article begin the second of the two issues of the *Journal* devoted to research in the university.

Dr. Taylor received her A.B. from the University of Wisconsin, her PH.D. from Bryn Mawr; she taught first at Vassar and then at Bryn Mawr, where she was Professor of Latin from 1927 until 1952, and Dean of the Graduate School from 1942 until 1952; she is currently Professor Emerita. She has been the recipient of numerous fellowships, memberships, and honorary degrees, and has published widely in professional journals. She is the author of *Local Cults in Etruria, The Divinity of the Roman Emperor,* and *Party Politics in the Age of Caesar.* At the time of the address, she was Visiting Professor at Harvard University.

CURIOSITY has been much more cursed than praised, for the word is commoner in a bad sense than in a good. "Curious" and "curiosity" come from the Latin root *cura* (care, concern), with the suffix *-osus*, meaning "full of," and the concern with which men are often filled is for their neighbors' affairs. That is the sense of *curiosus* in its earliest occurrence in Latin, a diatribe in a play of Plautus against horrid curious people who are interested in other people's business because they haven't any of their own. That sense of the word is to be found in proverbs in various languages. There is the English version, "Curiosity is ill manners in the house of another." The stock American example, "Curiosity killed the cat," points up the danger of too much curiosity and fits with the idea, which goes back at least to Saint Augustine, that God made hell for the curious.

But by the title which I provided before I prepared the speech I was committed to praise curiosity, and so I went for help to the wonderful subject catalogue in Widener Library which has often been my salvation. I found only two titles, one of which, a German disquisition on the Psychology of "Neugier," I did not look up. The other was promising. It was entitled "Curiosity," and the statement on the title page was singularly apposite, a poem delivered at Cambridge before the Phi Beta Kappa Society, August 27, 1829. The author was Charles Sprague, a self-taught banker who was prominent in the literary life of Boston in his day. Here too I was disappointed to find that most of the poem dealt with the evils of curiosity, that is, with the desire for sensa-

tionalism which the author found not only in man's concern for his neighbor's business but in the drama, the press, and even the pulpit of his day. But toward the end I was relieved to find an apostrophe to man, who knows no bounds in his desire for knowledge.

> How wide the gulf he clears, how bold the flight
> That bears him upward to the realm of light,
> By restless Curiosity inspired
> Through all his subject world he roves untired.

This is the theme carried out in the direct address to the members of Phi Beta Kappa:

> How bright the boundless prospect there on high;
> How rich the pearls that here all hidden lie
> . . . . . .
> Ye who were lapped in wisdom's murmuring bowers
> Who still to bright improvement yield your hours,
> To you the privilege and the power belong,
> To give my theme the grace of living song,
> Yours be the flapping of the eagle's wing
> To dare the loftiest crag and heavenward spring.

Nevertheless, even in Sprague's panegyric on man's restless curiosity there is a grim note on the dangers of piercing the unknown, dangers that are as old as the time when woman, not man, was the first to eat the forbidden fruit, dangers of which we are constantly aware in this nuclear age. But there is nothing we can do to keep man from such curiosity. It is, as Thomas Hobbes said, the quality which not less than reason distinguishes man from beasts: "Curiosity is a desire to know why and how; such as is in no living creature but man; so that man is distinguished not only by his reason but also by this singular passion from other animals; in whom the appetite for food and other pleasures of sense, by predominance, take away the care of knowing causes; which is a lust of the mind that by a perseverance of delight in the continual and indefatigable generation of knowledge, exceedeth the short vehemence of any carnal pleasure" (*De homine* I.VI).

And so I am going to praise curiosity (not in heroic couplets)—good curiosity, of course, desire to know and the willingness to take trouble to find out. I begin by saying that it is the quality I enjoy most in students. I'd rather have a serious question any day than an answer

based on the book, or, heaven help me, on my own words, which sound so depressing when repeated back to me, even when they are repeated accurately. Sometimes the question is easily answered to provide the student with facts that he needs, but often, even when I think I know the answer, it is a challenge. I have to put complicated material into simple terms and when I finish I sometimes find that I have got rid of a lot of non-essential trappings and that the subject is clearer to me than it was before. And if I can't answer the question, it is even more challenging, for here is something to find out. I am grateful to many a student for leading me into unfamiliar by-paths and sometimes to a major road, on which I had never turned before.

I like to think that the possession of such a desire to know is characteristic of the intellectual ability and achievement that Phi Beta Kappa recognizes. But honesty compels me to admit that some of the most curious are not elected to Phi Beta Kappa. There are strong-minded individuals who are so much absorbed in something that has fired them with lust for knowledge that they refrain from concerning themselves with certain requirements of the curriculum. I could mention as an example a person now making a name for herself in writing, who as an undergraduate was so deeply engaged in searching for the treasures of poetry in several languages that she did not take the trouble until after a failure to pass her required science. There are plenty of examples among scientists who have treated in the same cavalier fashion the requirements in the humanities. If A. E. Housman, the greatest Latinist and one of the great poets of his age, had been an American, he would have been included in this group: he was so much absorbed in literature at Oxford that he neglected the history and philosophy demanded for honors in Oxford Greats. These people are especially annoying, as I know from experience, to an administrator, but we respect them and from time to time after they have become famous elect them repentantly to the Phi Beta Kappa Society which passed them by in the days when they already had promise.

But they are almost surely not present among the Phi Beta Kappas whom we honor today. You belong to the people who are unwilling to do anything badly or are curious about everything or perhaps have some sense of the interrelation of knowledge and can find your own interests in every subject. You have been exposed in general requirements to a number of different subjects, and have chosen your major

subject because it particularly stirred your desire to know more. In pursuing that subject you have learned to do the hard and occasionally boring work that is essential if you are to gratify your curiosity and get the facts on which you can make up your mind; you have acquired the ability to see where you are wrong and to change your point of view and give up a pet theory in the light of new evidence. You have, in short, had discipline. And perhaps through your major subject you have arrived at some sense of the interrelation of knowledge. At some institutions there is an effort today to give students that sense through courses in General Education with a capital G and a capital E. But the interrelations you get in such courses are second hand, somebody else's, not your own, as the connections of your own specialty are. I know nothing more exciting in teaching (an exciting profession in my view) than seeing students suddenly make such connections. Incidentally, in their suggestions of interrelationships not less than in their questions students can teach their teachers, and I owe much to them for opening closed doors to me. It is one of the strengths of our American educational system that students are able in many varied combinations of subject matter to make their own integrations of material. I recently heard an English scholar, now teaching in America, contrast the varied backgrounds and combinations of subjects that he found among his American students with the more homogeneous training of his English students and emphasize the advantages he had derived from contact through his American students with fields that were unfamiliar to him.

The specialist whose mind is not open to contacts outside his field fits the definition of a specialist as a man who knows more and more about less and less, and usually he is of as little use in his specialty as he is in society. Either he hasn't got a questing mind or he has been the victim of circumstances which have dulled his curiosity even in scholarly activities. These circumstances exist in some, emphatically not all, of the great co-operative research programs, particularly in the sciences, where the director assigns specific tasks to his co-workers without giving them a share in the general plan or encouraging them to use their own initiative. The result is that they work blindly, with little idea what the general objectives are. As I know from reading letters and editorials in that very interesting and well written weekly, *Science*, there is vigorous protest against this totalitarian method of

carrying out investigations. Similar inhuman research schemes are, incidentally, not unknown in the humanities. I think of certain vocabulary studies where the poor graduate student has been set to collecting material of value possibly to the professor, but for the student meaningless, even harmful.

Even for the work of individuals not engaged in a co-operative plan there has been a limitation on free inquiry through the channeling of research funds into what is known as applied science or into work which, it is announced, should be in some way beneficial to mankind. That is a way of killing the goose that laid the golden egg, for, as is constantly pointed out now in pleas for "basic" science, many of the important applications of science have been the result of accidental discoveries made by men who simply wanted to know something without any idea that it would serve any useful purpose. The chances of making a really significant discovery are much better if you have your mind on your problem rather than on mankind.

Fortunately there is more encouragement of the free questing mind now than there was a few years ago. Other foundations have accepted the objective consistently held by the Guggenheim Foundation, an objective that, as stated by the Director, Dr. Henry Allen Moe, is "to make opportunities for the ablest persons to do what they want to do." Sometimes the scholar knows what he is seeking, as Michael Ventris did, who, hearing at the age of fourteen a lecture on the Mycenean writing known as Linear B, determined to solve it, and eventually, with the co-operation of many other scholars, did reach the solution—the epoch-making discovery of our times in the ancient field. He did it by trying one language after another until eventually Greek provided the answer, an answer that has led to a radical revision of the history of the second millennium before Christ. It was a remarkable achievement, more wonderful than Champollion's success in reading Egyptian hieroglyphs, for he had a Greek version to guide him. It is good to remember that there are other languages to conquer—Etruscan for instance, where the valiant efforts of able men have so far met with very limited success. One of the exciting things about our times is the number of new worlds to conquer. I remember a story I read in my youth before either Pole had been discovered, a story of a man who found the North Pole and then died without telling anyone about it, because he did not want to take from other men the purpose that had

guided his life. He did not suspect that later men would find even more challenging targets in outer space.

Probably only the great of the earth can focus their curiosity over the years on one purpose. Most of us have a variety of things we want to know, and our interests change with our experience. New problems present themselves from all sorts of chance occurrences: a question from a student or a friend, a new book or an old book which on re-reading has meaning for you, a puzzle in a familiar text on which you suddenly think you can get an answer. I can't really explain why a given problem becomes arresting. (Perhaps I ought to have read that German book on the psychology of curiosity.) I only know that when the problem begins to nag you, you might as well give in and work on it, for it will not let you go. You have no idea whether it is important or not, and sometimes when you have the answer you find it trivial and you put the work of weeks in the wastebasket. But sometimes the answer looks good, and what you need then is someone with whom you can talk about it, for putting it into words makes it clearer to you and the comments of a frank friend can show you your weakness. But one shouldn't be too easily discouraged by the comments; for they may mean simply that you have a lot more work to do.

The important thing is to keep an open mind, receptive to light from any quarter. It may come from the quarter where you least expect it. You will forgive me if I illustrate from my own experience to show the sort of thing that may help you to understand problems in your own field.

I have spent my life teaching Latin literature and producing studies on Roman religion and Roman politics, some of them of a regrettably technical nature (it's harder to write a general book than a technical book). I want to know how the Romans thought and felt, what they learned at school, what they read and talked about in their leisure hours, what their sense of values was, the nature of their legal system and of their government of an empire, what the impact of Greek civilization on theirs was and how they handed down the treasure stores of Greece to future ages, how this polytheistic people, always hospitable to foreign gods, became monotheists, and how Rome became the center of a great religion which inherited the claim of universality that had once belonged to Roman rule. If I am trying to reconstruct a fragmentary document preserved on a broken stone, I find myself involved

in complicated linguistic, legal, and institutional problems. If I am interpreting a poem, I need to understand the human heart. A few years ago there was much talk of what was called cross-fertilization of disciplines, and fellowships were offered to help scholars burrow into another subject that would illuminate their own specialty. But the trouble with me is that I need all the subjects. Just lately in interpreting Lucretius I have been able to cope not inadequately with discussions of the evolution of society and of language, but I have gone far beyond my depth in trying to compare Lucretius' atom with the atom of today. I am far from being able to achieve the synthesis needed for the reconstruction of the way things were at Rome, but everything that I can understand can help me fill in the details of the picture. Not least important is a knowledge of the world in which I live. I regard the hour a day I spend over the *New York Times* as an important part of my preparation for my work. In order to interpret a past age you need a frame of reference, and you have to make it in your surroundings. I give two examples of the way in which the American scene has helped me to see Rome.

Imperial Rome, like our great American cities, especially in the days I can remember before immigration quotas were fixed (Rome never fixed quotas), was a melting pot, a city of many nations, with separated groups who maintained their foods, their languages, their customs and religions; groups very much like the little Italys of Boston and other American cities, where the language and the "mores" of the old country were long maintained, where the festivals and churches still honor the saints and madonnas of the towns from which the immigrants came. The problem of assimilation was much the same in Rome as it was in the United States. I was fortunate in the work to which I happened to be assigned in a year in Washington during World War II. I found myself concerned with foreign nationality groups in the United States, and the experience has been invaluable in the study of imperial Rome.

On the Roman election system, which was almost impossible to see in the light of national elections under our two-party system, I suddenly got illumination from listening to the radio during a national nominating convention. I don't remember whether it was Republican or Democratic, for I listen to both. The convention is curiously like the Roman election. All the delegates have to go to one place to cast

their ballots, just as the Romans had to go to Rome to vote. The strength of the candidate depends on his personal rather than on his ideological connections, and that is like Rome where the parties were personal groupings. The candidate and his representatives have to go around in advance and ask people to vote for them. When one western delegation voted for Roosevelt in 1932, the reason they gave was that Jim Farley alone had pled for their vote. The Romans liked to be asked, to be supplicated, as they state it, for their vote, and they refused to cast their ballots for the younger Cato because he would not deign to ask them. You cannot press the resemblances too far, but the nominating convention has been very useful to me. It has set me on a fascinating problem of detection. In our nominating conventions you know where everybody comes from, but at Rome the place of origin of political figures is often not recorded. Yet it is very important, and I have been engaged in trying to run Roman senators to their native towns. It has led me to search through all sorts of material, for instance the coins they issued (they often placed on their coins images of the gods of their town of origin), and, more important still, the names on tombstones in Italian towns. With some of the senators I have been successful, and I am always hoping to track down some more.

These are, I am aware, relatively unimportant matters in the general picture. I can't see things whole. But I can recognize the people who can.

As an example of a man who, with his activities centered in the law, a field that extends through all of life, really has made a synthesis of his knowledge, and is continually adding to the store, I should like to mention perhaps the greatest American of today, Judge Learned Hand. I had the privilege several years ago in Rome of taking him to the Forum, where I always enjoy trying, particularly for the non-specialist, to recreate the life of the center of the Roman world. Usually in the Forum I talk, with interruptions for questions from time to time. But Judge Hand's questions began as we started down the ramp and did not end until the Forum closed. He started with the big public trials, on which by good luck I was fairly well prepared, and ranged through politics, literature, and religion, with which I could cope. But soon we got to architectural problems, including the use of building stone, where I am weak. Presently we arrived at the late classical and early Christian period where his background was far better than

mine. As we left, his wife said, "you thought you were guiding a judge and instead you had a prosecuting attorney." It was an exhilarating experience to encounter such insatiable, such informed, such disciplined curiosity.

Perhaps you think I have drawn my illustration of curiosity from people who have maintained the same field of interest through their undergraduate course and their professional life, whereas some of you plan to enter business or a profession that has no connection with your university major in French or Economics or Biology. But perhaps you won't look back on your training with any more regret than I look back on the first three years of my college course when, though continuing a little work in classics, I was trying to be a mathematician. The hard discipline I got in endless toil over solving knotty problems, ending, until I reached my limit in mathematics, with the sudden joy of solution, has been a priceless experience for me in dealing with very different material. I learned there that if one method didn't produce results you tried another. There is a story that someone asked Thomas Edison if 28,000 experiments conducted on a storage battery were not wasted effort. "What do you mean, wasted effort," he answered, "I now know 28,000 things that won't work." You can apply such experience, even with less than 28,000 trials, to other problems you want to solve in your profession or in your business, even in the relations with people with which you are inevitably concerned in the family, the community, the state, and the nation. Contrary to the view that used to be expressed by educators (most of them seem to have given it up now) the discipline you acquire in one subject can be transferred to another. But you've got to search for the details you need to complete the picture, to realize which details are pertinent and which are not. You have to keep your curiosity alive, for, as Samuel Johnson put it, it is "in great and noble minds the first passion and the last."

The Problem of Space for the Sciences in the University

GEORGE P. FULTON
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THE provision of space for classrooms, teaching laboratories, library resources, and research in the sciences is a major problem which must be solved by educational institutions with reference to the expansion of enrollments, dynamic changes in the content of the sciences, and the increased importance of science not only as a profession but as a cultural component of the liberal arts curriculum.

In keeping with the growth of Boston University and the College of Liberal Arts in particular, a discussion of the problem of space for teaching and research in the sciences is appropriate and timely. Although expanding enrollments are taxing the facilities for the humanities as well, the greatest complexities are found in the sciences, where the diversification in laboratories with expensive installations creates major difficulties in financing and consumes vast amounts of floor space. In the humanities also, traditional concepts of the classroom are changing with increasing use of conference rooms and workshops.

In an urban university where land is at a premium, expansion is likely to occur by the acquisition and remodeling of older buildings and by vertical growth. Multistory science buildings have certain advantages in economy of space and integration of units within the department. However, this type of building is likely to be more expensive and less efficient in terms of modern conveniences than the horizontal type of campus structure now being erected in California on the vast campuses of the mushrooming state colleges. The latter are esthetic, functional, and perhaps less expensive on a dollar value basis.

The interdisciplinary approach to science inherent in the designation "Science Center" is the key to progress and must be the main theme in planning and development of the sciences. Because of the nature of long-established urban universities in relation to their physical surroundings, it may not be possible to locate all components of

The author wishes to thank Miss Irene Christopher, Chief Reference Librarian, Chenery Library, Boston University, for assistance with source material.

the science center within direct physical continuity of each other. However, the concept of interdisciplinary research is essentially a state of mind, and mere physical contiguity does not insure the implementation of the concept. Scientists at Boston University are already engaged in interdisciplinary research; for example, the co-operation of physicists, chemists, biochemists, medical researchers, and biologists on the Institutional Grant for Basic Research on Growth as administered by Dr. Henry Lemon of the Medical School.

Although concern has been expressed about the increasing dependence of universities on federal aid for support of research in the sciences, the private universities could not afford without assistance the new technological facilities which are required to maintain the pace of modern science. As an example, the Atomic Energy Commission has established training grants designed to provide universities with the funds to purchase expensive radiation and isotope equipment needed for the instruction of students in radiation biology, radiochemistry, and nuclear physics. Scientists themselves are obligated to assist in the appropriation of funds from various granting agencies in support of their research programs, and department heads must assume the responsibility of working with their administrative superiors in efforts to obtain funds for physical space for research and for teaching as provided by such agencies as the National Institutes of Health and the National Science Foundation, usually on a matching basis. The new Boston University Medical Research Building has been made possible largely as the result of a construction grant obtained from NIH, and this successful venture should serve as a catalyst for the development of other sciences and the solution of their space problems.

From the classical and historical point of view, ample precedence can be found for "sponsored research." For example, the Museum at ancient Alexandria was not unlike a modern scientific research institute or sponsored research as it exists in science departments of universities across the United States.[1] The Museum was financed by royal patrons or by the state. It possessed dormitories for scientists and their assistants, conference rooms, laboratories, botanical and zoological gardens, an anatomical museum, observatories, and a tremendous library. Although formal teaching was minimal at the Museum, schol-

[1]George Sarton, *Ancient Science and Modern Civilization* (Lincoln, Nebraska, 1954), p. 8.

arly informal instruction of the graduate school type flourished by exposure of apprentices to renowned scientists in the laboratory. Group or team research, which is currently so prevalent, was practised in Alexandria. A science library was associated with the Museum; and this traditional partnership has its present-day counterpart in the Research Institute with its own science library,[2] and (on a less pretentious scale) in the graduate research activities of the science departments of modern universities with their departmental libraries.

Modern industry is a new potential source of support for basic science at the university. At present it has a somewhat detrimental effect on the future of science because of the substantially lower salaries offered for scientists by universities. The source of future scientists as provided by university training is being stifled by short-sighted competitive procedures which deplete the universities of their outstanding staff members. The situation can be effectively reversed if and when industry and universities realize their common responsibility to science and to society and follow through with constructive measures. Perhaps an arrangement of joint appointments in universities and in industrial research organizations would be mutually beneficial. This might provide considerable help for universities by underwriting a portion of the salary costs of highly-trained specialists. Furthermore, partial subsidization of basic science on campus by industry could be a major factor in contributing to the solution of the space problem for science at the university. In Europe, a brewing company has provided substantial support to a college for many years. Although superlative aid has been provided to universities by such sources as the Ford Foundation, assistance from American industry is still the exception.

Opportunities are relatively unexplored for industry to establish research laboratories in the sciences at universities, endow chairs of an interdisciplinary nature, as in biophysics, or underwrite the expenses of on-going basic research. At Boston University, funds are needed to provide space, facilities, and additional manpower to develop our ideas concerning interdisciplinary research on the part of biologists, chemists, economists, oceanographers, and others as related to fish and the fisheries industry. We need assistance for the development of the

[2]M. P. Hilligan, *Libraries for Research and Industry: Planning and Equipment* (New York, 1955).

quantitative aspects of the biological sciences such as biophysics, electron microscopy, histochemistry, biochemical genetics, and radiation biology. In the field of biology, we have substantial research programs in vascular physiology, biology of growth, endocrinology, and systematic parasitology, but space is a major limiting factor. Financial assistance is needed to develop our research potential in other areas of biology. A marine biological station is needed and space for museum displays is a major requirement. Furthermore, the sciences and the humanities share a major need for a specialist trained in the history of science; and this would seem to be an excellent chance for a pharmaceutical concern or biological supply house to establish an endowed chair, particularly since pharmaceutical concerns traditionally publish extensive articles on the history of science and medicine in their elaborate house organs which are so widely distributed.

In consignment of space for the sciences, an area for a department library is considered to be indispensable. Innumerable examples can be cited, such as the libraries established in the science departments at Brown, Harvard, Oxford, and Sheffield. In fact, this practice, which is so disturbing to many modern librarians, was accepted in the famous library at Alexandria. The scientists working at the Museum kept manuscripts in their specialties at home or in their laboratories.[3] Thus the precursor of the modern problem of division of books between the main library and the departmental library existed in the Alexandrian period. According to the National Research Council Report on Design, Construction and Equipment of Laboratories, science library facilities should be easily accessible and located in the laboratory building. "There is pressure on the part of the administration of some of our smaller colleges to combine science libraries with the main college library in a separate building, often quite remote from the science laboratories. This attitude cannot be defended and stems from an ignorance on the part of the administration as to how teaching and research scientists operate."[4]

In actual practice, the university librarian and the heads of the science departments should have no real difficulty in deciding which

[3]George Sarton, *A History of Science: Hellenistic Science and Culture in the Last Three Centuries B.C.* (Cambridge, Mass., 1959), p. 144.

[4]H. S. Coleman, *Laboratory Design: National Research Council Report on Design, Construction and Equipment of Laboratories* (New York, 1951), p. 87.

material should be kept in the main library and which should be assigned to the departmental libraries.

In planning for space for the sciences or for any expansion in teaching facilities at the university level, a decision must be made concerning the relative merits of the large auditorium as compared with multiple smaller units either with or without facilities for closed circuit television. The Department of Biology at Boston University has had several years of experience with the use of a large auditorium for a class of six hundred students enrolled in the introductory course in general biology. The academic features and organizational aspects of this course have been described previously in the *Graduate Journal*.[5] We are convinced that our present large class with small discussion sections is much more effective than our previous efforts. Even if we had the manpower for multiple duplicate lectures, the advantages of the present system of single lectures in units by staff members with professional training in the area represented by their unit outweigh the traditional system. The blackboard cannot be used effectively in the large auditorium, but the overhead projector is vastly superior for classrooms of all sizes. The lecturer faces his class at all times and writes with normal handwriting on a revolvable transparent scroll. The "blackboard work" is projected above his shoulder onto a screen where it can be seen distinctly and without glare in a fully-lighted auditorium by one thousand or more students. A modern public-address system will take the guesswork out of the minds of the students, obviate voice strain on the part of the instructor, and compensate for speakers with soft voices.

The televising of lectures into multiple small classrooms is an alternative to the use of auditoria for large introductory classes, and facilities to permit closed and open circuit telecasting must be incorporated into space for the sciences. Traditional arguments in favor of small classroom teaching are usually cited in support of the television method, although experience has shown that audience retention may be high in theaters, opera houses, lecture halls, music halls, stadia, and convention halls, where interest is high and the audience is large. A much stronger argument for television can be made in the case of the

[5]G. P. Fulton and W. N. Tiffney, "The New Look in General Biology at Boston University: An Intercollegiate Approach," *Boston University Graduate Journal*, VI (1958), 77–82.

biological sciences in view of the vast amount of illustrative material available for use in teaching of biology coupled with the adaptability of television as a practical means of showing the material with equal clarity to all students and without distractions and interruptions of either students or lecturer. For example, we believe that our present course in general biology could be improved by the use of television as a means of using efficiently, with proper timing and the advantage of interchangeability, important teaching aids such as motion picture films (frequently only short excerpts are required), lantern slides, demonstrations of dissections, or actual experiments (close-ups required), models, charts, "blackboard work" (overhead projection as substitute), and living animals in action (e.g., movements of snake, ameboid action, etc.). The advantages and implications of video-tape recording for courses which must be repeated in second semesters, evening divisions, and summer terms require thorough exploration in planning for the future and in consideration of the space needs for the sciences.

If the broadcasting is done on open circuit television, the nation as a whole becomes the potential audience and the possibilities are exciting for intercollegiate co-operation at the national level. In fact, the space problems for science in secondary schools might be alleviated considerably by a combination of telecast lectures and regional lab-mobile and recitative coverage with the "experiment of the week," originating from a local university. A plan of this type could provide gifted high school students with college-accredited courses while still in high school and simultaneously provide refresher training in subject matter to high school teachers.[6]

The remark of Dr. Vannevar Bush, internationally-famous scientist trained as an electrical engineer, is indicative of the opportunities and responsibilities inherent in the biological sciences: "If I were a young man, I would go into biology." Exciting scientific discoveries of the future lie in the field of biology, but these can only result from an interdisciplinary research effort involving the application of basic knowledge and techniques from the fields of related sciences such as physics

[6]The author has prepared a detailed proposal entitled "The Simultaneous Teaching of a College Course in General Biology to Gifted Students in High Schools and to Students at Boston University by Means of Open Circuit Television." This proposal has not yet been implemented.

and chemistry. Since the departments of chemistry and physics have their own job to do, the biologists themselves must pioneer by establishing laboratories in biophysics and biochemistry and in retaining the services of competent men who are willing and able to bridge the gap between fields. Consequently, departments of biology in particular are confronted with omnivorous problems in space and manpower.

The present trend in science is to design laboratories with maximal adaptability in view of changing needs. Permanent expensive bench installations are avoided as much as possible. Provisions are usually made for alteration of the subdivisions of unit areas by use of dry wall removable partitions. Since requirements may change rather rapidly, flexibility is considered to be advantageous. This procedure has been followed in the construction of the new physiological laboratory at Oxford and in many industrial laboratories.

However, one of the special problems of departments of biology in regard to space is the fact that the laboratories for research and for teaching are extremely diverse and hence non-interchangeable. This imposes a necessary but difficult financial burden on university administrations. For example, the taxonomic ichthyologist cannot share a teaching laboratory with the physiologist; the equipment is vastly different. Since most physiological work in the student laboratory is done in a standing position, high benches and stools are usually provided. For this reason, the physiological laboratory is not suitable for use in such courses as cytology, histology, or embryology, which require microscopy and benches designed for sedentary work. The biochemical laboratory and microbiological laboratory must be equipped with a liberal supply of sinks and chemical hoods in relation to student capacity. Laboratories for work in entomology, botany, and mammalogy must be provided with extensive facilities for specimen storage and adequate display units. Furthermore, ready access must be provided to vivaria, herbaria, greenhouse, and departmental museum facilities. Some measure of the diversity of the space requirements in the biological sciences may be indicated by the following partial list of types of teaching and research laboratories recognized as essential.

1. *General Biology Laboratories* with preparation room and storage room. Since enrollments are high (600 or more at Boston University), these laboratories are not available for use by any course other than the introductory.

2. *Invertebrate Zoology Laboratory* with preparation room and storage room. Courses in parasitology can also be scheduled in this type of laboratory.
3. *Vertebrate Anatomy Laboratory* with preparation room and storage room. Courses in vertebrate zoology can also be scheduled in this laboratory.
4. *Cytology, Histology, and Embryology Laboratory*
5. *Physiology Laboratory*
6. *Microbiology Laboratory*
7. *Genetics Laboratory*
8. *Laboratory for courses in Entomology, Botany, and Ornithology*
9. *Laboratory for courses in Ichthyology, Mammalogy, Herpetology*
10. *Biochemistry Laboratory*
11. *Biophysics Laboratory*
12. *Isotopes Laboratory*
13. *Greenhouse, Herbaria, Vivaria, Museum facilities*
14. *Animal Rooms*
15. *Dark Rooms*
16. *Electronic Shop, Machine Shop*
17. *Cold Rooms and Hot Rooms*
18. *Balance and Instrument Rooms*
19. *Supply Room*
20. *Department Library*

The necessity for careful planning and efficient use of available space is even more important than mere square footage. This is particularly true with respect to research laboratories. For example, it is generally recognized that a fluctuation in room temperature of five to ten degrees may alter enzymatic processes in living systems to such an extent that the biological data may be worthless. At least the research portions of space to be provided for the biological sciences must be *air conditioned*. This includes the animal rooms. In addition, special rooms must be constructed for experimentation at low and high temperatures, and provisions for the maintenance of a constant temperature are necessary. In order to provide for critical control of heat, light, and air conditioning, entire buildings in some cases, but especially laboratory sections of research buildings, are being constructed devoid of windows. It is probably advisable to explore this possibility extensively in planning space for the sciences and it might be well to have windowless, artificially-lighted, air-conditioned research laboratories for sponsored research and graduate research in one section of

the building, but with ready access to conventionally-lighted offices and teaching laboratories with ample window exposure.

Space problems are vexing, but universities must solve them if they are to catch up in the present and be prepared for the future.

Space Research

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TWO years of the age of space have already gone by. The new era was ushered in by the rumble and roar of rockets climbing upward with their payload of instruments into regions which had hitherto been beyond the reach of man. The pace of world development is becoming bewildering, especially when we realize that this pace is accelerating year by year. New ways of life spread like waves over the surface of the earth. Before the industrial revolution has had time to reach to more remote regions, man has coaxed the energy from the atom. Concurrently we find that we are in the atomic age and the age of space. It is natural to ask where this headlong rush will take us and what returns we may expect from our scientific endeavors.

The exploration of the space surrounding the earth can be regarded as a commitment that we have to ourselves and to the future. It is our duty to explore and increase our knowledge in all areas of science and art. A rejection of this duty would condemn us at best to a lingering decline into decadence, and at worst to a total collapse of our civilization. There seems to be no "steady state" condition; history shows us that civilizations must either expand or perish. Since we have limited resources it is inevitable that advances will be made in some areas of research with a corresponding curtailment in others. The emphasis at the moment is on space research and it is opportune to discuss this area in general, and its possible impact on the University in particular.

The cost of space research is enormous, and if we take the narrow view of expecting direct material dividends, it is probably true to say that the results obtained so far have not been a fair return for the ex-

penditure. It is difficult to evaluate research work in terms of dollars, and the question is not of paramount importance to the basic researcher. Faraday's induction experiments cost less than ten dollars, but made possible the billion-dollar electrical industry. On the other hand, the considerable expenditure of the alchemists to manufacture gold was a poor investment. The artificial satellites have given us information that we could not have obtained by any other means. Recent work has shown that the outer shell of the atmosphere, called the exosphere, is an extremely variable region, pulsating and heaving under the action of radiation from the sun. In the last two years we have been able to measure the density of the exosphere, and it has been found to be much thicker than was hitherto supposed. Cosmic ray detectors have warned us of the dangerous belt of charged particles that surrounds the earth and through which prospective space travelers must pass. Meteor particles have been detected with small microphones before they enter the earth's atmosphere, whereas in previous research we were forced to watch them disintegrate as they plowed into the upper atmosphere.

No one will deny that scientific results have been obtained from the satellite experiments, but an appraisal of this information is difficult to make. One can say with certainty that the results could have been obtained at a lower cost if the work had proceeded at a normal pace and had not been inflamed by the competition with Russia. Some satellites have been duplications of previous shots, and one, at least, might possibly be criticized for being a scientific stunt. In assessing the value of space research, one fact should be borne in mind. The cost of the scientific equipment represents a very small portion of the total cost. The measuring instruments used in space are simple in construction and seldom weigh more than a few pounds. More than ninety per cent of the money is spent on the rocket that delivers the equipment into its orbit. The rockets are a product of our defense systems and the cost must be regarded as an insurance for our future safety and an inevitable requirement of our times. The ten per cent spent on basic science may indeed yield a light for posterity from the otherwise dark missile race.

During times of peace a university department should undertake no research in which the scientist is clearly a military tool. In our present plight, military research and development must continue, but this is

the direct responsibility of scientists attached to the armed forces. The faculty member may, however, be requested to act at times as a consultant because of some special knowledge or experience that he possesses. It is sometimes a little difficult to differentiate between basic and militaristic research, but as an approximate dividing line we can use the security classifications, "Top Secret," "Secret," and "Confidential." The Graduate School should concentrate on research that does not fall within the security classification. From past action this indeed seems to be the policy of the University, and it would be beneficial for the University to make clear with public statements, repeated if necessary, that this University in times of peace undertakes no classified research projects.

In the years ahead Boston University can play a useful part in space research and in other fields where physics and astronomy overlap. The Astronomy Department was joined to the Physics Department in 1957 to promote an interchange of students and facilities in the two fields. A recent outcome of this change has been the establishment of a B.A. degree with a concentration in "Physics with Astronomy." Beyond the baccalaureate, it is hoped that physics graduate students will be able to choose a topic for research in the field of astronomy. The greatest hindrance to research at the moment is the lack of facilities—laboratory, workshop, and library. Full-time graduate students are also entitled to a separate office from which they can co-ordinate their research work. The Observatory in its present position is ideal for undergraduate teaching and is useful for certain research projects such as lunar photography, but it can never compete effectively with observatories that are established beyond the glare of city lights in the more favorable climatic regions. The physical laboratories are meager and are hardly adequate for the commencement of even a pilot research program, in which a researcher shows that a certain idea will succeed and is worth following. To construct an adequate physics building, similar to the buildings found in other major universities, would, of course, be expensive and would constitute a major development program. Until we have an adequate facility we are striving to use what we have to the best advantage. To illustrate the present capabilities and the future needs it is useful to consider two research projects that are at present being carried out in the field of astronomy.

At the request of the Air Force Cambridge Research Center, we are

investigating possible methods of detecting micrometeorites. There are many small meteors that enter the earth's atmosphere but do not become visible and do not produce detectable ionization. It is a difficult problem to observe these small bodies and yet they are of importance to the earth, since we accumulate some 10,000 tons of this material each day. We are hoping to devise a method that will enable us to measure the speed and direction of approach of the particle so that we may deduce its orbit and life history in space. At the present time this work involves reading research, calculations, and basic thinking and can therefore be performed within the confines of an office. If we are successful in our planning then we will expect to be able to draw on workshop and laboratory facilities to develop prototype measuring equipment. If we wish to embark upon an observational program we may have to use an observatory site away from the Charles River Campus, which will involve rental of real estate and other administrative problems.

A second research project is being supported by the National Aeronautics and Space Administration and concerns the riddle of tektites. Tektites are glassy objects found in various locations on the surface of the earth. The objects do not seem to be related to the rock strata in which they are found and the majority of geologists conclude that tektites are extraterrestrial in origin: that is to say, they have fallen from outer space. On the other hand, there is no nickel-iron content in these glassy fragments and astronomers feel that tektites are not related to the meteorites which constitute the normal interplanetary debris. A healthy dichotomy is developing and we are hoping that our research will help solve the problem. The work began this summer with a field trip to a tektite "fall" near Bedias, Texas, where samples of tektites were collected and the local terrain studied. A detailed examination of the samples will follow, involving measurement of annealing strain, water content, microscopic inclusions, etc. In addition there are several theoretical problems to investigate; for example, we hope to examine the suggestion that tektites are fragments that have been chipped off the moon by meteoric impact and fallen to the earth. In extending this work it may be necessary to strengthen the present research facilities in the laboratory and workshop, and enlarge the office space. As an interim measure we hope to be able to use research facilities already established in the Boston area; certain chemical and

physical measurements may be carried out on the tektite samples by local industrial and university laboratories. This work would be carried out under our direction and under a subcontract from the tektite project.

The Graduate School certainly has a great potential for important research in many fields of knowledge. The nucleus for this research has already been assembled in the faculty, and faculty members and graduate students should be given every opportunity to conduct research for the advancement of knowledge, and for the enhancement of the reputation of the University.

Farewell to Disinterestedness

The New Age in Science

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THOSE of us who were adult before World War II may remember —or even retain—an image of science which I consider obsolete, although it has not yet been consciously rejected at any level of common consent. This image was one that bookish youngsters who were destined for scientific careers arrived at somewhere around early maturity. It considered science as a manifestation of the most disinterested kind of curiosity: the true scientist thirsted for knowledge, but was devoid of any ulterior motive. He sought knowledge not for its benefits, nor could he be deterred by its possible ill consequences.

The maturing of this image was usually preceded, in the late adolescent mind, by a period in which a humanitarian conception of science predominated. The budding scientist would always believe that the endeavor which captivated him most at the moment was the highest of which the human mind was capable; a form of self-aggrandizement seemingly quite necessary for sustaining ambition at this stage of life.

The non-scientists did not have so great a need to rarefy their concepts of science, since they obtained no ego-advancement thereby.

But the image of a field of work in the mind of an outsider to it is greatly influenced by the testimony of its devotees. What better or, anyway, more vivid witnesses could there be? Perhaps in this way, in the public mind, disinterested curiosity came to be considered the motive of the "highest" kind of science, with humanitarianism and material gain or comfort occupying successively lower positions in the scale of values. The most striking testimony to the prestige of this kind of work was the adulation of Albert Einstein that grew to such astonishing dimensions in the twenties and thirties. On a smaller scale was the cult of Marie Curie, whose most intense manifestation was the successful motion-picture biography with Greer Garson portraying Mme. Curie in her dedicated career.

The world now knows that the greatest triumph of applied practical science, nuclear energy, came out of a line of thought in which the work of Einstein and the Curies occupied quite central positions. It seems to me that this fact flatly contradicts the doctrine of the disinterestedness of the pure scientist. I am not impressed with the various elaborate interpretations which pretend that there is no contradiction. It has been represented as a mere irony of fate of which the pure scientist is the victim, or as testimony to the power of disinterestedness. Surely the latter argument contains its own refutation! The pure scientist would have to be unconscious not to realize this. To be sure, the popular legend attributes just such unconsciousness to him—calling it "innocence" or "unworldliness." Anyone who does not talk like the president of General Motors is unworldly. The non-scientific writings of Einstein show a realistic, sophisticated mind, and a willingness to entertain optimistic conjectures whose more immediate impracticality he probably realized quite well.

"Knowledge is power." So said both Francis Bacon and Thomas Hobbes, leading contributors to the early development of the scientific point of view. Why disregard their testimony? Just as the saying "honesty is the best policy" shows how honesty can be cultivated for practical purposes rather than for its own sake, the oft-quoted "knowledge is power" shows the ulterior purpose of scientific truth-seeking. From the earliest times to the latest, the history of science contains examples of pure theory in the service of pure material advantage: Farrington (*Greek Science*) gives evidence for the origin of Greek science in early technology; Pascal started the mathematical theory of

probability in response to a gambler's inquiry; Willard Gibbs wrote his doctor's thesis on a problem of engineering; the theory of partial differential equations solved the problem of transatlantic telegraphy; Maxwell's equations of electromagnetism guided the inventors of wireless communication. Lorentz, the main creator of the classical electron theory, devoted the last years of his life to the problem of redesigning the dikes and locks of the Zuider Zee; for this the hard-headed Dutch, who of all nations have made probably the greatest contribution *per capita* to physical science, made him a national hero. A realistic assessment of pure science would attribute to it the greatest interestedness. Those with sufficient imagination to satisfy their entirely human craving for power without needing to hold it in their bare hands, so to speak, will find power in its most concentrated form in pure science. As symbol replacing object is the very basis of human thought, so pure science is the very sublimation of power.

Along with the myth of disinterestedness grew that of irresponsibility. Since the scientist was unmotivated by anything but sheer curiosity, the consequences of his findings were none of his business. Society could use them, like fire, for good or evil. Such was the compartmentalization of human functions which this mythmaking presupposed, that the potentiality for good or evil was considered to have nothing whatever to do with the operation or the motivation of the institution of science. To be sure, the doctrine of irresponsibility has taken quite a beating in recent years. Some of the more tender-minded scientists have reluctantly advocated responsibility for the anti-humanitarian uses of science; and some of the more tough-minded have eagerly accepted responsibility, too—positive responsibility, for the development of armaments.

As things have stood until recently, science simply means man being hedonistic. At best, it is the institutionalized intellectual form of the drives that make man seek security, comfort, and physical satisfaction, and avoid work and pain. At worst, modern man analyzing the universe is not really different from the cave man understanding the principle of inertia well enough to design a war club; he would, if he could, use the cosmos as a club to crush the enemies of his own national state.

In angry rejection of these ill consequences, it has been claimed that science has run out of control. Let us enumerate its most conspicuous

negative results. It has made war too destructive. It has produced an explosive population expansion, and increasingly efficient means of communication and travel; these combined have led to political and social institutions of unmanageable size (the modern super-states), and to an excessive ever-presentness of man on the natural landscape.

In highly-developed industrial societies, by the multiplication of creature comforts it has devaluated them; by the efficiency of machines it has made man superfluous, throwing him into a further self-defeating pursuit of comfort; by too great a reduction of working hours it has taken away the savor of recreation. By the success of its theories it has undermined credulity and the older bases of religious belief, revelation, and miracle, giving rise—whether justifiably or not—to a sense of emotional deprivation. And it has compounded all these problems by giving us more leisure and prolonged life in which to struggle with our sense of purposelessness.

In its effort to solve all these emotional and social problems it has finally given us psychology and social science, which have committed the ultimate outrage of manipulating us, of devaluating us to the status of machines, of depriving us of the sensation of uniqueness and free will in the wellsprings of our being.

I am appalled at this list because I am myself a scientist. Not that I feel that I have contributed excessively to the creation of these problems. But I chose a scientific career under the spell of the myth of disinterestedness, with the help of a strong residue of humanitarianism left from the preceding state of my thinking; and I now *see* the interest hidden behind the disinterested attitudes absorbed from the stream of scientific wishful thinking.

Under the spur of disappointment in the realization of the scientific dream, many have been led to reject it. Science is held to have got out of control; we need a "moratorium on science." I think a better perspective is as follows: science was an exploring company sent out by society with a well-defined mission, namely to draw a map of nature and to obtain power over it. But no limit was set to its charter; just as maps of the American colonies in the seventeenth century show a strip of territory commencing at the Atlantic coast but extending indefinitely westward. Here is, perhaps, the clue to the role of disinterestedness in the man of science: it was the mark of the man who had the complete support of society in his task of the conquest of nature,

who was freed by society of any other intellectual or spiritual obligation in the furthering of this purpose.

I now propose the following thesis: that this program of exploration and exploitation has now reached an end, so far as its original motives are concerned. Man's spirit, or whatever it is in man that makes him reject servitude to any institution, however much of his own making, now considers that science has grown to the point where its consequences control man, more than they enable him to control his environment.

It is not strange that this should happen at the moment of science's seemingly complete triumph, in terms of achievement. The very completeness of the triumph reveals that the mission has been accomplished. The all-out advocate of science will not agree to this: man has not yet conquered space, nor has he yet been able to postpone death indefinitely. But this advocate is still following the old charter, which I claim has, unknown to him, been withdrawn for drastic modification. For who can say that because, in principle, we can traverse interstellar space or live forever, we must do so? This seems more like servitude than freedom. The plea, "Because it was there," is a confession of a kind of enslavement to the physical world which, although it was made by a mountaineer, might serve as the slogan of the space age. I would like to retain the right *not* to climb Mount Everest, or what not, if I prefer. Maybe I should climb it—but only if I am better off thereby, or happier, or really want to do so. I do not doubt that Sir Edmund Hilary derived an immense satisfaction from his feat, but his famous reply hints at something almost tragic. And I myself, after the first thrill following his and Tenzing's achievement, feel not richer, but poorer, that the highest mountain in the world has been humbled like nearly all the rest.

The charter is now, I think, being subjected to review. Obviously, it is not going to be withdrawn. But it would be better to divest ourselves of the fantasies, if we hold them, of "moratoria on science," etc. Such demands, and, I realize, my own sense of guilt at accepting the myth of scientific disinterestedness, are over-emotional reactions to disappointment at the failure of the realization of the scientific dream to bring about undiluted happiness for one and all. But science is indispensable. Our world is utterly dependent on it; there are billions of persons now alive who would die almost at once if science vanished

today, and whose lives would be greatly shortened if science did not continue to progress. It is too late to vent more than a passing regret on this circumstance.

What the new charter will be like cannot be foretold now. But it will have somehow to embody a solution to the problem of freeing man from the compulsion to continue searching for that which he no longer needs as much as he did when he was in desperate, primitive poverty. Man being human, work and accomplishment are necessary to his sense of well-being; he does not need to be freed from work entirely, just because once men almost universally lived out their brief lives in crushing toil. Man's conscious being rebels at death, but the events of birth, maturing, and rearing of a family lose their meaning outside the context of the drama in which death is the last act. How man might free himself from the compulsion to eliminate all work, and to seek the indefinite prolongation of life, I do not know. These problems concern mainly engineering and medicine, of course; may I therefore skip them as being outside my field.

The charter of physics, which is my own field, will be harder to review, since classically physics has been, next to mathematics, the model of the disinterested science. I would like, in the remainder of this essay, to discuss this question in relation to the professional and institutional locus in which I function, the Physics Department of Boston University. It is also relevant, I think, that Boston University is a church-sponsored institution. This confers on it a special responsibility for contributing to the development of socially responsible attitudes in science, beyond that which belongs to liberal arts institutions in general.

It must first be admitted, I think, that the relationship between a science department and a church-sponsored parent university necessarily contains some elements of ambivalence, because of the traditional conflict between scientific skepticism and religious belief. But after all, through living together over the centuries, science and religion have reached a *modus vivendi*. Religion has relaxed the literalness of its dogmas, and science has abandoned its earlier brash attempt to destroy religious belief. Not that the relationship has become entirely comfortable, but science has made the world over so completely that religion has had to adjust itself; for example, a church-sponsored university, to have a valid claim to universality in its curriculum, has to

have departments of science respected by their disciplines. The process of accommodation has been still further helped by certain elements of partial sympathy within religion: Protestantism itself was an expression of some of the same attitudes (for example, opposition to institutionalized authority) which gave rise to science, while much of early science was nurtured in the bosom of the Catholic Church.

I hope that these things I have mentioned will not be taken as meant in an offensive spirit, but in the nature of admitting the worst prior to suggesting the better relationship that could exist in the future. It is important to realize that historically there is little innate sympathy between science and religion, however obvious it may seem, because science as it now stands, crowned with material successes and feverishly exploiting them in every direction, seems less likely than ever to attract the sympathy of a primarily religious-minded person. Yet it is my contention that, with its charter "under review," science is entering a period of crisis worthy of such a person's sympathetic attention.

There are many forces operating against the adaptation of the physical sciences to a new, socially responsible orientation: such as their extreme specialization, leading to preoccupation of the scientist with the approval of his discipline at large rather than that of his local institution; the bureaucratization of university administration; simple inertia; etc. Bigger than all of these, however, is the fact of the almost overwhelming identification of present-day physical science with the cause of national defense. For the physical sciences have, in recent years, evolved into organisms symbiotic with the military in this country. To quote one simple and probably sufficiently convincing statistic: in a recent issue (June 1, 1959) of the *Physical Review*, fourteen articles acknowledged financial support from some national defense agency, seven acknowledged the Atomic Energy Commission alone, while only nine acknowledged neither.

It should be admitted that the military sponsoring agencies are decent and tolerant, and manifest an understanding of the conditions under which scientific work needs to be done. Physicists, moreover, are not subservient souls. But it would be absurd to claim that this close bond between physics and defense needs has no influence on the evolution of the science; a scanning of the tables of contents of physics journals over the past decade will reveal how whole special fields have

dwindled, while others grew from nothingness into domination in periods of a few years, in response to military stimuli.

Is there anything that a church-sponsored university can do to mitigate this situation? Let me first speak in negative terms: I am not ready to set down anything in the nature of a program. An alliance between religion and science is an improbable thing, and any scientist will hesitate to bid directly for support from religious sources, which he feels are more than likely to show complete lack of comprehension of his problems. Moreover, the religious ties of a major church-sponsored university become quite tenuous when they reach the level at which science departments operate; so perhaps little is to be expected, realistically speaking. But still I would like to plead for a sympathetic ambiance toward socially-responsible science within the university.

My scientific colleagues and I stand, at least professionally speaking, on one side of the very real wall that separates science and religion. Most of us, I think, are on the scientific side of this wall in terms of philosophical attitudes, too. Let me now speak for myself only. I am, to oversimplify somewhat, philosophically uncommitted, with a foot in either camp, but critical of both. I have here mainly discussed the ethical shortcomings of science. I have not emphasized so much what I think are the shortcomings of religion; but for purposes of the present discussion I can summarize these rather briefly: no longer able to maintain certain traditional doctrines that science has literally destroyed, religion has not yet succeeded in replacing these with articles of belief, unchallengeable by science, and having the same dynamic power over men's minds as the old ones.

What religion can do about this problem I do not at all know. I am aware that many men of religion are aware of it and are conscientiously grappling with it. I would like to propose, as a beginning modest compared to the main goal though still a worthy task, that some progress toward the revitalization of religion and the humanization of science could be realized if the problems were combined. A religiously-oriented university with secularly-oriented science departments seems as good a place as any to make a start on this work.